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ABSTRACT

In order to construct a scientifically designed evaluative instrument to assess the motor fitness of boys in the primary grades, 30 test items purported to measure muscular strength, muscular endurance, cardiovascular endurance, power, speed, agility, flexibility, and balance were administered to an incidental sample of 238 boys ages 6 to 9 years. An intercorrelational matrix was constructed for the factor analysis of the data using the principal axes method. Seven factors having eigenvalues above 1.000 and accounting for 65.17% of the variance were isolated. The first of two test batteries developed included the test items that loaded highest on each factor and were as follows: Clarke's strength composite; McCloy's endurance ratio; Wells' sit and reach; Bass' balance on a stick, lengthwise; wrist flexion and extension flexibility; arm flexion on the back flexibility; and modified push-ups. The second battery, developed for more administrative feasibility, included items that loaded high on each factor and eliminated composite scores and ratios. The items in test battery II were grip strength; 300 yard run; Wells' sit and reach; Bass' balance on a stick, lengthwise; wrist flexion and extension flexibility; Arm Flexion on the back flexibility; and modified push-ups. (Author)

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THE CONSTRUCTION OF A MOTOR FITNESS TEST BATTERY FOR BOYS IN THE LOWER ELEMENTARY GRADES*

by

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This investigation is a division of a much larger study involving the following purposes:

1. To construct motor fitness test batteries for boys and for girls in the lower elementary grades.

2. To construct gross muscular strength test batteries for these same populations.

3. To determine the differences between the motor fitness levels of boys at the various age levels, and the differences between the motor fitness levels of girls at the various age levels.

4. To determine the difference between the motor fitness levels of boys and girls in the lower elementary grades.

5. To construct motor fitness test norms for boys and for girls in the lower elementary grades.

Introduction

A basic responsibility of professional physical educators has been the evaluation of the physical status of students. Measurement and/or evaluation are necessary in order to determine

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one's motor fitness proficiency and as a means of determining if physical education programs are adequately fulfilling established goals and objectives.

In considering the construction of a motor fitness test battery for pupils in the lower elementary grades, one should consider the measuring instruments suitable for the particular age, growth, and maturational characteristics of the subjects. Furthermore, administrative feasibility for the individual classroom teacher, availability of equipment, economy of time, and the practice of testing a maximum number of subjects in a minimum amount of time should be considered in developing an effective motor fitness test battery. Motor fitness tests are functional as well as objective and are not beyond the reach of any school system desirous of initiating a measurement program. Motor fitness test batteries, originally developed for military purposes, have been constructed for junior high, senior high, and college students; presently, however, few scientifically constructed motor fitness test batteries for pupils in the lower elementary grades exist. Consequently, the motor fitness levels of lower elementary grade pupils are usually not assessed and they do not receive any assistance through special developmental activities which might improve motor fitness.

Purpose

The purpose of this division of the study was to statistically construct a test battery to assess the motor fitness level of boys in the lower elementary grades.

Procedures

Subjects. The subjects for the study were 238 boys in the first, second, and third grades who ranged in age between six and nine years. All subjects were tested during a 13-week period in the spring of 1972. The time required for testing allowed each subject ample rest and recovery which could have otherwise influenced his performance. No subject was known to have a physical defect or organic deficiency.

Motor Fitness Components. Following a review of related literature and tabulation of a questionnaire sent to 162 members of the Research Council of the American Association for Health, Physical Education, and Recreation, eight components were identified and selected as appropriate measures for use in a motor fitness test battery for boys in the lower elementary grades. The eight components selected were: (1) cardiovascular endurance; (2) muscular strength; (3) muscular endurance; (4) speed; (5) flexibility; (6) power; (7) agility; and (8) balance.

Experimental Test Items. Thirty experimental test items were selected to measure the eight components of motor fitness and were required to meet the following criteria: (1) the items were scored in a continuous fashion; (2) the items were highly related to one of the identified components of motor fitness as demonstrated in previous research studies; (3) the items had established validity, objectivity, and reliability coefficients;

and (4) the items were the most appropriate measures of the motor fitness components selected for inclusion in the study. The 30 experimental test items selected were: (1) vertical jump; (2) modified pull-ups; (3) bent-arm hang; (4) 50-yard dash; (5) 10-yard dash; (6) dodging run; (7) modified push-ups; (8) Scott obstacle race; (9) Illinois agility run; (10) six-second time run; (11) standing broad jump; (12) grip strength; (13) leg lift; (14) wrist flexion and extension flexibility; (15) trunk-hip flexion and extension flexibility; (16) leg flexion and extension flexibility; (17) neck flexion and extension flexibility; (18) arm flexion on the back flexibility; (19) Wells' sit and reach; (20) Bass balance on stick, lengthwise; (21) Bass balance on stick, crosswise; (22) rail walk; (23) Clarke's strength composite; (24) shoulder extension strength; (25) knee extension strength; (26) ankle plantar flexion strength; (27) McCloy's endurance ratio; (28) time limit shuttle run; (29) 300-yard run; and (30) 600-yard run-walk.

Results

Analysis of Data. The Pearson product-moment technique was used to intercorrelate the scores from the 30 test items. The resulting correlational matrix was used to factor analyze the data using the principal axes method with the varimax criterion for rotation. The factor analysis yielded seven factors with eigenvalues above 1,000.

Factor I appeared to be primarily a muscular strength factor. The highest loading variables were as follows:

Variables	Factor Loading
Clarke's Strength Composite	.889
Knee extension strength	.778
Ankle plantar flexion strength	.750
Shoulder extension strength	.750
Grip strength	.732
Leg lift	.702

The highest loading test items on Factor I represent the hypothesized muscular strength component of motor fitness. Factor I accounted for 36.5 percent of the total variance.

Factor II was not identified as a single component of motor fitness, but did include test items purported to measure cardiovascular endurance, speed, power, and agility. This factor accounted for 7.2 percent of the variance. The following variables received the highest loadings on Factor II:

Variables	Factor Loading
McCloy's Endurance Ratio	-.881
Three hundred yard run	-.883
Six hundred yard run-walk	-.748
Fifty yard dash	-.706
Scott obstacle race	-.692
Illinois agility run	-.668

The common element most apparent in these items appeared to be speed-stamina, but this factor did not warrant classification

due to the high factor loadings of other elements. With the presence of three purported measures of cardiovascular endurance, two combination speed and/or power test items, and two agility test items, there was not enough support for the identification of this factor.

Factor III was identified as flexibility and more specifically as trunk-hip flexibility on the basis of relatively high rotated factor loadings for the Wells' sit and reach test and trunk-hip flexion and extension flexibility. Additional support of this factor as a flexibility measure of the trunk-hip region existed in that no high or moderately high factor loadings were obtained for the test items purporting to measure the other seven hypothesized motor fitness components included in this study. Factor III accounted for 5.5 percent of the variance, and the highest loading variables were as follows:

Variables	Factor Loading
Wells' sit and reach	.857
Trunk-hip flexion and extension flexibility	.737
Wrist flexion and extension flexibility	.212
Standing broad jump	.166
Bent arm hang	.142
Vertical jump	.127

Factor IV was identified as balance and more specifically as static balance on the basis of a relatively high rotated factor loading for the Bass balance on stick, lengthwise and crosswise. The Bass balance stick tests have been identified as

measures of static balance through previous factor analysis research. Factor IV accounted for 4.5 percent of the variance, and the highest loading variables were as follows:

Variables	Factor Loading
Bass balance on stick, lengthwise	.781
Bass balance on stick, crosswise	.757
Vertical jump	.388
Rail walk	.368
Standing broad jump	.321
Neck flexion and extension flexibility	.298

Factor V, like Factor III, was identified as flexibility; however, the elements of flexibility in this factor appear to exist in the extremities of the body based on high factor loadings of the Leighton flexometer measures for wrist flexion and extension. Factor V accounted for 4.2 percent of the variance, and the highest loading variables were as follows:

Variables	Factor Loading
Wrist flexion and extension flexibility	-.718
Leg flexion and extension flexibility	-.687
Neck flexion and extension flexibility	-.468
Time limit shuttle run	-.229
Scott obstacle race	.197
Dodging run	.177

Factor VI was also identified as flexibility due to high rotated factor loadings for arm flexion on the back flexibility and neck flexion and extension flexibility. No pattern existed

of any significant concentration of variables to warrant identification of Factor VI other than as a flexibility factor. Factor VI accounted for 3.9 percent of the variance, and the following variables received the highest loadings on this factor:

Variables	Factor Loading
Arm flexion on the back flexibility	-.717
Neck flexion and extension flexibility	-.376
Dodging run	-.324
Leg flexion and extension flexibility	-.272
Wrist flexion and extension flexibility	.245
Rail walk	.238

Factor VII was identified as muscular endurance based on the high loadings for modified push-ups, bent arm hang, and modified pull-ups. These test items had been hypothesized to be measures of muscular endurance. Factor VII accounted for 3.6 percent of the variance, and the variables receiving the highest loadings were as follows:

Variables	Factor Loading
Modified push-ups	-.756
Bent arm hang	-.756
Modified pull-ups	-.721
Six hundred yard run-walk	.242

Development of Motor Fitness Test Batteries

From the factor analysis of the test data, two separate test batteries were developed to assess the motor fitness of boys in the lower elementary grades. Test Battery I included the

test items with the highest rotated factor loadings on each of the seven factors. The seven test items with their rotated factor loadings on each factor they measure are as follows:

Factor	Test Item	Loading
I	Clarke's Strength Composite	.889
II	McCloy's Endurance Ratio	-.881
III	Wells' sit and reach	.857
IV	Balance on stick, lengthwise	.781
V	Wrist flexion and extension flexibility	.718
VI	Arm flexion on the back flexibility	-.717
VII	Modified push-ups	-.756

This test battery would consist of the most valid measure of the seven factors identified.

Test Battery II was developed and consisted of more administratively feasible test items. Only two test items differed from the measures included in Test Battery I, and these test items were ~~second~~ high in factor loadings on the two factors involved. Grip strength replaced Clarke's Strength composite, and the 300-yard run replaced McCloy's Endurance Ratio. The test items in Test Battery II with their rotated factor loadings on each factor they measure are as follows:

Factor	Test Item	Loading
I	Grip strength	.732
II	300-yard run	-.833
III	Wells' sit and reach	.857
IV	Balance on stick, lengthwise	.781

V	Wrist flexion and extension flexibility	.718
VI	Arm flexion on the back flexibility	-.717
VII	[illegible] push-ups	-.756

Table 1

Rotated Factor Loadings

	VARIABLES	Factor I	Factor II
1.	Vertical Jump	.566	.225
2.	Modified Pull-Ups	.006	.289
3.	Bent Arm Hang	.158	.236
4.	Fifty-Yard Dash	-.457	-.706
5.	Ten-Yard Dash	-.347	-.473
6.	Dodging Run	-.260	-.603
7.	Modified Push-Ups	.167	.188
8.	Scott Obstacle Race	-.291	-.692
9.	Illinois Agility Run	-.289	-.668
10.	Six-Second Run	.438	.615
11.	Standing Broad Jump	.590	.437
12.	Grip Strength	.732	.265
13.	Leg Lift	.702	.236
14.	Wrist Flexion and Extension Flexibility	.049	.107
15.	Trunk-Hip Flexion and Extension Flexibility	.121	.215
16.	Leg Flexion and Extension Flexibility	.065	.074
17.	Neck Flexion and Extension Flexibility	.145	-.004
18.	Arm Flexion on the Back Flexibility	.017	.088
19.	Wells' Sit and Reach	.006	-.074
20.	Bass Balance on Stick (Lengthwise)	.145	.151
21.	Bass Balance on Stick (Crosswise)	.224	.168
22.	Rail Walk	.229	.255
23.	Clarke's Strength Composite	.889	.268
24.	Shoulder Extension Strength	.750	.167
25.	Knee Extension Strength	.778	.275
26.	Ankle Plantar Flexion Strength	.750	.208
27.	McCloy's Endurance Ratio	-.285	-.881
28.	Time-Limit Shuttle Run	.359	.564
29.	Three-Hundred Yard Run	-.187	-.833
30.	Six-Hundred Yard Run-Walk	-.058	-.748
	Eigenvalues	10.922	2.144
	Cumulative Percentage of Eigenvalues	36.41%	43.55%

Table 1 Continued

Factor III	Factor IV	Factor V	Factor VI	Factor VII	h^2
.127	.388	.077	-.136	-.114	.575
.020	.213	.004	.085	-.721	.656
.142	.047	-.091	.017	-.756	.683
-.061	-.178	-.030	.038	.149	.767
-.095	-.207	.059	.224	.031	.451
-.052	-.153	.177	-.324	.169	.622
.034	.034	-.124	-.122	-.756	.667
-.035	-.200	.197	.135	.197	.701
.062	-.287	.131	-.097	.079	.649
.043	.090	-.006	.028	-.216	.627
.166	.321	-.068	-.022	-.183	.619
.075	.123	-.029	.078	-.079	.640
.113	.144	-.020	.230	-.139	.655
.212	-.037	-.718	.245	-.011	.636
.737	.158	-.119	-.067	-.240	.705
-.009	.009	-.687	-.272	-.111	.568
-.106	.298	-.468	-.376	-.149	.504
.112	-.000	-.079	-.717	-.011	.541
.857	-.080	-.026	-.051	.014	.752
.051	.781	.017	.011	-.119	.671
-.035	.757	-.031	-.070	-.061	.662
.014	.368	-.175	.238	-.079	.346
-.027	.166	-.092	-.063	-.070	.926
-.058	.038	-.140	-.129	-.014	.632
.034	-.024	-.000	.069	-.095	.697
-.025	.267	-.110	-.097	-.056	.702
-.026	-.052	.025	.091	.162	.896
.018	.227	-.229	.152	-.152	.597
-.000	-.029	.033	.130	.128	.764
-.060	-.032	-.090	.174	.242	.665
1.648	1.360	1.247	1.164	1.066	
49.05%	53.58%	57.74%	61.61%	65.17%	

Moto Fitness Hull Scales

MEAN =	2.83	30.3	87.2	260.9	24.3	14.65	13.97	12.62	11.88
S.D. =	.73	2.4	15.9	111.6	9.5	12.29	6.96	7.38	7.8
RANGE =	1.79-6.71	23-38	57-136	50-560	8-56	0-75.8	3-35	1-51	4-64
100	0.33	38.7	31.6	651.3	54.0	57.63	38	38	39.18
95	0.58	37.8	37.1	612.5	51.0	53.33	36	35.5	36.43
90	0.83	37.0	42.7	573.4	48.1	49.05	33	33	33.72
85	1.08	36.2	48.3	534.3	45.1	44.75	31	30	30.99
80	1.33	35.3	53.8	495.3	42.1	40.45	28.5	28	28.26
75	1.58	34.5	59.4	456.2	39.2	36.15	26	25	25.53
70	1.83	33.6	64.9	417.2	36.3	31.85	24	23	22.80
65	2.08	32.8	70.5	378.1	33.3	27.53	21	20	20.07
60	2.33	32.0	76.1	339.0	30.4	23.3	19	18	17.34
55	2.58	31.2	81.6	300.0	27.4	18.95	16	15	14.61
50	2.83	30.3	87.2	260.9	24.5	14.65	14	12.5	11.88
45	3.08	29.4	92.7	222.9	21.5	10.35	11.5	10	9.15
40	3.33	28.6	98.3	182.8	18.6	6.05	9	7.5	6.42
35	3.58	27.8	103.9	143.7	15.6	1.75	7	5	3.69
30	3.83	27.0	109.4	104.7	12.7	-	4	2.5	0.96
25	4.08	26.1	115.0	65.6	9.7	-	2	.5	-
20	4.33	25.2	120.5	26.5	6.8	-	.5	-	-
15	4.58	24.4	126.1	-	3.8	-	-	-	-
10	4.83	23.6	131.7	-	.9	-	-	-	-
5	5.08	22.7	137.2	-	-	-	-	-	-
0	5.33	21.9	142.8	-	-	-	-	-	-

	RAIL WALK (total segments)	PLANTAR FLEXION (degrees)	PLANTAR FLEXION (degrees)	PLANTAR FLEXION (degrees)	PLANTAR FLEXION (degrees)	PLANTAR FLEXION (degrees)	REACH
MEAN =	4.52	121.87	161.16	117.99	142	91	11.2
S.D. =	2.87	16.88	16.99	12.30	15	13	2.2
RANGE =	2-28	75-163	114-203	86-149	93-197	61-127	5-17
100	14.5	181	221	161	196	134	18.7
95	13.5	175	215	157	190	130	18.0
90	12.5	169	209	152	185	126	17.2
85	11.5	163	203	148	180	122	16.5
80	10.5	157	197	144	174	117	15.7
75	9.5	151	191	140	169	113	15.0
70	8.5	146	185	135	164	108	14.2
65	7.5	140	179	131	158	104	13.5
60	6.5	134	173	127	153	100	12.7
55	5.5	128	167	122	147	95	12.0
50	4.5	122	161	118	142	91	11.2
45	3.5	116	155	114	137	87	10.5
40	2.5	110	149	109	131	82	9.7
35	1.5	104	143	105	126	78	9.0
30	.5	98	137	101	120	73	8.2
25	-	92	132	97	115	69	7.5
20	-	87	126	92	110	65	6.7
15	-	81	120	88	104	60	6.0
10	-	75	114	84	99	56	5.2
5	-	69	108	79	93	52	4.5
0	-	63	102	75	88	47	3.7

Motor Fitness Hull Scales

GIRLS 6 TO 9 YEARS OF AGE

N = 183

MEAN =	7	40.7	25.81	25.35	26.41	30.05	10.74	3.23	207.76
S.D. =	1.8	6.9	3.32	2.74	3.04	2.87	1.16	0.28	26.91
RANGE =	2-12	20.3-62	18.8-40	19.6-34.2	20.1-35.2	24-38	8.2-15.5	2.6-4.5	146.3-287
100	13.3	64.9	14.21	13.83	15.81	40	6.74	2.33	113.86
95	12.7	62.3	15.35	16.80	16.57	39	7.14	2.42	123.27
90	12.0	60.1	16.53	17.73	17.93	38	7.54	2.51	132.68
85	11.3	57.3	17.69	18.70	18.99	37	7.94	2.60	142.09
80	10.8	55.2	18.85	19.63	20.05	36	8.34	2.69	151.50
75	10.2	52.8	20.01	20.60	21.11	35	8.74	2.78	160.91
70	9.6	50.4	21.17	21.55	22.17	34	9.14	2.87	170.32
65	8.9	48.0	22.33	22.50	23.23	33	9.54	2.96	179.73
60	8.3	45.6	23.49	23.45	24.29	32	9.94	3.05	189.14
55	7.7	43.1	24.65	24.40	25.33	31	10.34	3.14	198.55
50	7.0	40.7	25.81	25.35	26.41	30	10.74	3.23	207.76
45	6.4	38.3	26.97	26.30	27.47	29	11.14	3.32	217.37
40	5.8	35.9	28.13	27.25	28.53	28	11.54	3.41	226.78
35	5.2	33.5	29.29	28.20	29.59	27	11.94	3.50	236.19
30	4.5	31.0	30.45	29.15	30.65	26	12.34	3.59	245.60
25	3.9	28.6	31.61	30.10	31.71	25	12.74	3.68	255.01
20	3.2	26.2	32.77	31.05	32.77	24	13.14	3.77	264.42
15	2.6	23.8	33.93	32.00	33.83	23	13.54	3.86	273.83
10	2.0	21.4	35.09	32.95	34.89	22	13.94	3.95	283.24
5	1.4	18.9	36.25	33.90	35.95	21	14.34	4.04	292.65
0	.7	16.5	37.41	34.85	37.01	20	14.74	4.13	302.06

MEAN =	3.05	28.2	96.2	138.6	21.6	11.2	5.28	10.6	1.92
S.D. =	0.15	3.6	11.3	9.2	3.7	8.2	1.96	5.73	7.1
RANGE =	1.0-3.39	20-35	61.2-139	32-162	5-32	4-55	0-10	2-30	4.0-47.0
100	1.15	21.4	50.2	121.0	14.2	42.0	30	36	41.95
95	1.24	24.3	54.2	138.0	14.0	37.3	28	33	38.25
90	1.31	25.7	58.2	135.3	14.4	35.3	26	31	36.75
85	1.39	26.8	62.2	135.3	28.9	34.0	25	29	33.85
80	1.48	27.9	66.2	132.0	15.4	30.3	23	26	31.15
75	1.56	29.0	70.2	129.8	23.9	27.9	22	24	28.15
70	1.69	30.1	74.2	127.6	23.5	25.2	18	21.5	25.75
65	1.78	31.2	78.2	125.3	18.9	20.8	15	19	23.25
60	1.89	32.3	82.2	123.1	24.4	17.2	14	17	20.35
55	1.85	29.4	86.2	120.8	23.9	14.5	12	15	17.65
50	2.05	28.3	90.2	198.6	21.4	11.2	9.5	12	14.95
45	3.34	27.6	94.2	166.2	18.2	8.4	7.2	10	12.25
40	3.43	26.8	98.2	130.1	16.3	5.7	4	7	9.55
35	3.62	25.9	102.2	101.9	13.9	3.5	2	5	6.85
30	3.81	25.0	106.2	69.6	11.3	-	1	2.5	4.15
25	4.00	24.1	110.2	37.4	8.8	-	-	.5	1.45
20	4.19	23.2	114.2	5.2	6.3	-	-	-	-
15	4.38	22.3	118.2	-	3.9	-	-	-	-
10	4.57	21.4	122.2	-	1.2	-	-	-	-
5	4.76	20.3	126.2	-	-	-	-	-	-
0	4.95	19.6	130.2	-	-	-	-	-	-

MEAN =	2.91	4.43	141.03	167.60	14.46	149.44	94.27	12.08
S.D. =	2.09	3.12	18.28	17.57	13.91	16.37	13.81	2.03
RANGE =	.4-14.2	.2-19	85-180	114-241	99-184	66-180	53-130	7-16
100	13.31	11.8	207	239	203	207	130	19.2
95	12.48	11	199	223	198	201	144	18.5
90	11.33	10.4	192	212	190	193	139	17.8
85	11.06	9.6	186	211	185	190	133	17.1
80	10.29	8.8	179	203	179	184	128	16.3
75	9.56	8.1	173	199	173	178	124	15.6
70	8.83	7.4	167	193	168	172	116	14.9
65	8.10	6.7	160	189	162	167	111	14.2
60	7.38	5.9	154	180	157	161	103	13.5
55	6.64	5.1	147	174	151	155	100	12.8
50	5.91	4.4	141	168	145	149	94	12.1
45	5.18	3.7	135	161	140	144	89	11.4
40	4.45	3.0	128	155	134	138	83	10.7
35	3.72	2.3	122	149	129	132	78	10.0
30	2.99	1.5	116	141	123	127	72	9.2
25	2.26	0.7	109	137	118	121	67	8.5
20	1.53		103	131	112	115	61	7.8
15	0.80		96	124	107	109	56	7.1
10	0.07		90	118	101	104	50	6.4
5			84	112	95	98	45	5.7
0			77	106	90	92	39	5.0

INSTRUCTIONS FOR ADMINISTERING TEST ITEMS

Vertical Jump

1. The subject chalked the fingertips, and with the feet flat on the base, placed the fingertips of one hand as high as possible on the vertical board.
2. The subject rechalked the fingertips, crouched, and jumped vertically, swinging the arms up vigorously and touching the board with the fingertips at the height of the jump.
3. Two trials were allowed, and the better score, determined by the distance measured to the nearest half-inch between the two marks, was recorded.

Modified Pull-Ups

1. The bar was adjusted to a height even with the bottom of the subject's sternum.
2. From a standing position, the subject grasped the bar with the palms upward and slid the feet under the bar until the legs and trunk were fully extended and the arms formed an angle of 90 degrees with the chest. The subject's feet were braced by an assistant.
3. The subject pulled the body upward to the bar until the chest touched the bar, then returned to the straight-arm position. The subject repeated the motion as many times as possible without resting between moves.
4. Each pull-up counted one point. Half credit was given if the subject sagged, pumped, or bent the knees, with a maximum of four half credits allowed.

50-Yard Dash

1. The subject started on the signal "ready--go" and ran the 50-yard distance as fast as possible.
2. One trial was allowed, unless the subject did not start properly and the score was the time to the nearest tenth of a second required to run the distance.

10-Yard Dash

1. Special equipment used for this test included a DeKan electronic timer with special start and stop mechanisms, 35 foot length of cord, alligator clips, and a starting block.
2. The subject assumed either a standing or sprint starting position with the toes and hands behind the starting line.
3. The signal for the subject to begin was an audio buzzer which simultaneously started the timing device.
4. The subject ran until the length of cord was pulled out of a special stop mount which stopped the timing device.
5. One trial was allowed, unless the subject started improperly and the score was the time to the nearest hundredth of a second required to run ten yards.

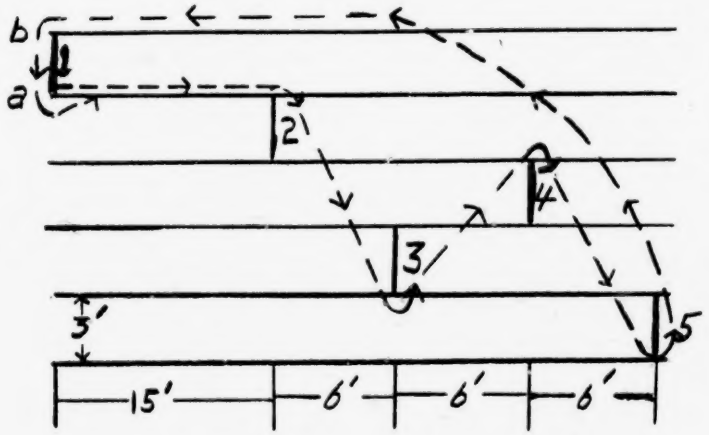
Bent-Arm Hang

1. An assistant raised the subject to the bar where the hands were placed shoulder width apart, the palms outward and the elbows flexed so that the chin was as the level of the bar. The legs were extended.

2. When the subject was in position, the assistant released the subject; the subject held the position as long as possible.
3. One trial was allowed. The score was the time to the nearest tenth of a second that the subject was able to maintain some flexion of the elbow.

Dodging Run

1. Course as diagrammed:



2. On the signal "go" the subject started from point a and ran the course in the following manner:
   a. ran straight ahead to hurdle 2, and turned right;
   b. ran to hurdle 3, and turned left;
   c. ran to hurdle 4, and turned right;
   d. ran around hurdle 5, and ran straight to hurdle 1;
   e. ran around hurdle 1, and then repeated the course.
3. Only one trial was allowed, unless the subject ran the course incorrectly and the score was the time to the nearest tenth of a second required to complete two rounds of the course.

Modified Push-Ups

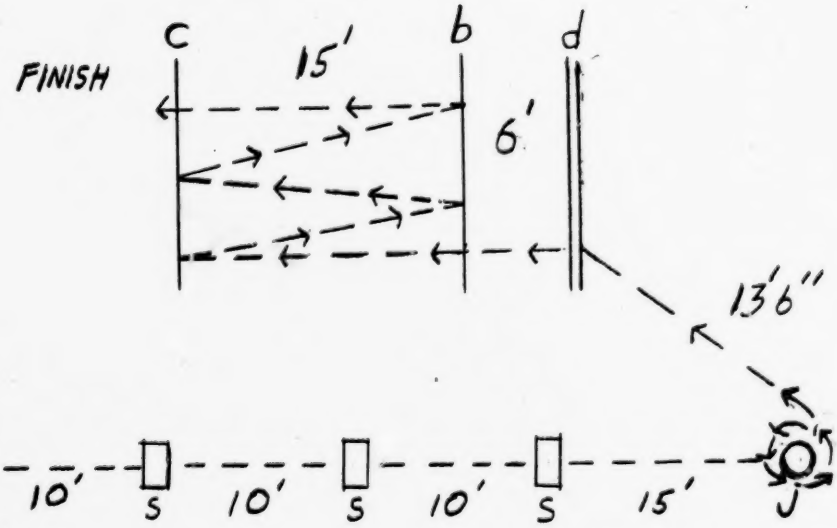
1. The subject held the front edge of a wooden bench, 13 inches in height, 20 inches long, and 14 inches wide, and assumed a front leaning rest position with the arms and body forming a 90 degree angle.
2. The subject lowered the body so that the upper chest touched the near edge of the bench, then raised to a straight-arm position.
3. The motion was performed as many times as possible and each push-up counted one point.
4. Half credit was given if the subject did not go completely down or did not push completely up, with a maximum of four half credits allowed.

Six-Second Time Run

1. At the starting signal the subject ran as fast as possible over a straight course 60 yards long, with yard markers spaced two yards apart.
2. The tester counted the third, fourth, and fifth seconds aloud, and at the end of six seconds, blew the whistle.
3. One trial was allowed and the score was the distance on the marker nearest the runner's position when six seconds had elapsed.

Scott Obstacle Race

1. Course as diagrammed:



a. starting line
b. line for shuttle
c. finish line
d. cross bar
j. wastebasket
s. 12" x 18" spot on floor
- path of runner

2. The test began with the subject in a supine position with the heels on line a.
3. On the signal to begin, the subject followed the course in this manner:
   a. got up and ran toward j;
   b. stepped on each square s with both feet;
   c. ran twice around j;
   d. went under the crossbar set 18 inches from the floor;
   e. ran to line c and shuttled between c and b until coming to line c for the third time.
4. Subjects were allowed to jog through the course one time prior to testing. Only one trial was allowed, unless the subject ran the course incorrectly and the score was the time to the nearest tenth of a second required to complete the course.

Standing Broad Jump

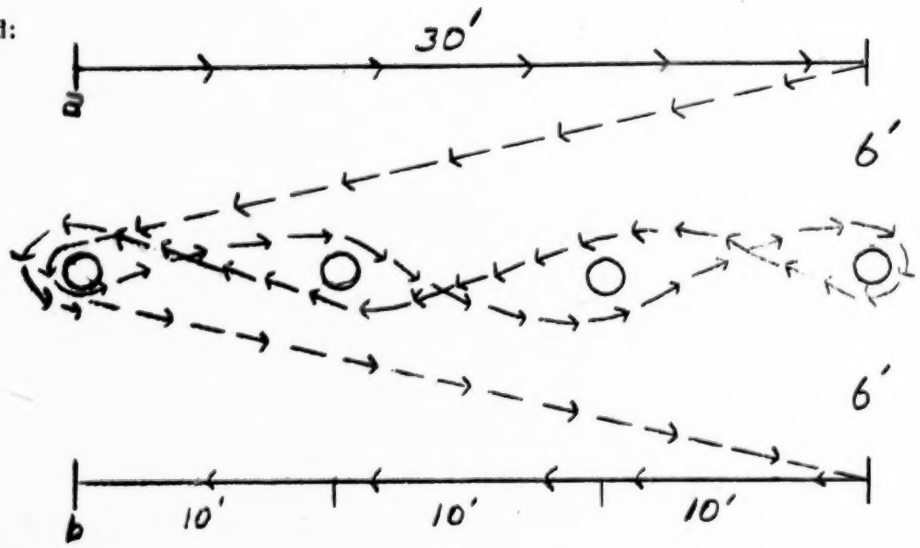
1. The subject stood with the toes of both feet touching the take-off line.
2. Taking off from both feet, the subject jumped as far as possible and landed on both feet.
3. Two trials were allowed with the better score recorded which was the distance measured to the nearest half-inch.

Grip Strength

1. The tester placed a manuometer in the palm of the subject's hand with the convex edge between the first and second joints of the fingers, the rounded edge against the base of the hand, and the dial face down.
2. In a standing position, the subject squeezed the manuometer, the hand forming a sweeping arc downward, with the elbow slightly bent. The hands were not allowed to touch the body or any object.
3. Two trials were allowed with the better score recorded.

Illinois Agility Run

1. Course as diagrammed:



a. starting line
b. finish line
x. wastebaskets
- path of runner

2. The subject assumed a prone position with the head just behind the starting line, and the hands at the side of the chest.
3. On the signal to begin, the subject ran the course in the following manner:
   a. jumped to both feet and ran the 30-foot straight distance;
   b. touched or crossed the line with at least one foot and reversed direction;
   c. ran back to the first wastebasket and turned left around it;
   d. ran a zig-zag dodge run left-right-left around the wastebaskets and turned around the last basket;
   e. repeated the zig-zag course coming back;
   f. turned left around the last basket;
   g. ran to the 30-foot line, reversed with at least one foot touching or crossing the line, and ran across the finish line.
4. The subject was allowed to jog through the course one time prior to testing. One trial was allowed, unless the subject ran the course incorrectly and the score was the time to the nearest tenth of a second required to complete the course.

Leg Lift

1. Equipment used for this test item included a back and leg dynamometer and a securing belt and bar.
2. The subject held the bar with the hands together in the center, palms down, so that the bar rested at the junction of the thighs and trunk.
3. The loop end of the belt was slipped over one end of the handle or crossbar; the free end of the belt was looped around the other end of the bar and tucked in under so that it rested next to the body.
4. The subject's feet were flat on the platform with the knees slightly bent. Maximum lifts occurred when the subject's legs were nearly straight at the end of the lifting effort.
5. Before the subject was instructed to left, the tester made sure that the arms and back were straight, and the head and chest were in an erect position.
6. The score recorded was the best of two trials.

Bass Balance on Stick (Lengthwise)

1. The subject balanced on a stick - one inch x one inch x 12 inches - using the preferred foot with the long axis of the stick parallel to the long axis of the foot.
2. At the starting signal, the subject held this position as long as possible up to 60 seconds.
3. Three trials were allowed.
4. The score was the sum of the times recorded to the nearest tenth of a second for the three trials.

Bass Balance on Stick (Crosswise)

1. Using the same equipment as in the lengthwise test, the subject balanced on the ball of the preferred foot with the long axis of the stick perpendicular to the long axis of the foot.
2. Other procedures are same as for lengthwise test.

Rail Walking

1. The subject walked forward on a hexagonal rail constructed of six boards, 3/4 inch wide, 3 1/2 inches deep, and 24 inches long, stepping once on each segment in succession.
2. The subject was not allowed to step on the corners.
3. The long axis of the foot was kept parallel with the long axis of the segment.
4. The trial ended when the subject violated the above directions or became unbalanced.
5. Two trials were allowed, with the better score recorded.
6. The score was determined by the number of segments successfully traversed.

Wells' Sit and Reach Test

1. Equipment used in testing included a calibrated flexibility measuring scale constructed according to Wells' specifications.
2. The subject sat on the floor, with the knees straight and the feet placed flat against the vertical portion of the measuring scale.
3. The subject bounced three times reaching forward along the measuring scale. On the fourth bounce, the subject reached as far forward as possible and held the position for two seconds.
4. The score was the distance to the nearest half-inch reached on the fourth bounce. A score of 11 indicated a reach to the point directly above the toes.

600-Yard Run-Walk

1. The subject was instructed to run as much of the distance as possible in order to complete the course in a minimum amount of time, though subjects were allowed to walk when necessary.
2. One trial was allowed and the score was the time to the nearest tenth of a second required to complete the 600-yard distance.

300-Yard Run

1. On the starting signal, the subject ran the length of the course (60 yards) five times in the style of a shuttle run.
2. One trial was allowed and the score was the time to the nearest tenth of a second required to complete the 300-yard distance.

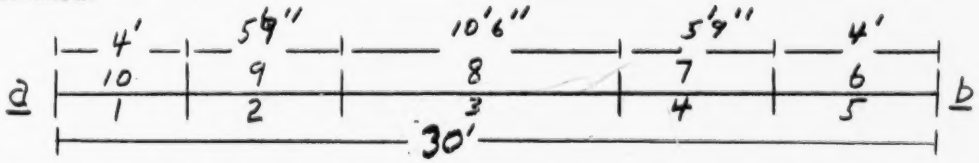
McCloy's Endurance Ratio

1. The proportion of times between short and long runs was considered an endurance ratio. McCloy's Endurance Ratio was determined from data obtained from performance on the 300-yard run and the six-second run.
2. The ratio was determined by use of the following formula:

$$\frac{\text{Time for 300-yard run}}{\text{Distance for 6-second run}}$$

Time-Limit Shuttle Run

1. Course as diagrammed:



2. The subject started behind starting line a, and on the signal to begin, ran to the other end of the course. After touching the floor beyond the end line, the subject ran back to the starting line.
3. The subject attempted to complete, in 20 seconds, as many trips of this circuit as possible.
4. Only one trial was allowed, unless the subject did not run the course correctly, and the score was the number of zones covered in 20 seconds. (Zones are numbered in the diagram.) One complete circuit of the course covered 10 zones.

Leighton Flexometer Measures

The following equipment was utilized for all of the flexometer measures:
Leighton flexometer
Armchair
Bench

1. Wrist flexion and extension
   a. The subject assumed a sitting position in a standard armchair, the back straight, the forearm resting on the chair arms, the fist doubled and extended beyond the chair arms, and the palm of the hand to be measured turned up with the instrument fastened to the thumb side of the fist.
   b. The subject moved the fist upward and backward in an arc as far as possible, and the dial was locked.
   c. The subject moved the fist forward, downward and backward in an arc as far as possible, and the pointer was locked.
   d. The forearm was not allowed to be raised from the chair arm during the movement.

2. Trunk-hip extension and flexion
   a. The subject assumed a standing position, with the feet together, the knees straight, and the arms extended above the head.
   b. The instrument was fastened to the side of the chest just below the armpit at nipple height.

c. The subject bent backward as far as possible, and the dial was locked.
d. The subject then bent forward as far as possible, and the pointer was locked.
e. The knees were kept straight throughout the movement. The feet were not allowed to be shifted, and the toes and heels were not allowed to be raised from the floor.

3. Leg extension and flexion
   a. The subject assumed a standing position with the back to the edge of a door facing, with one hip, one heel, and one shoulder blade held against the facing at all times.
   b. The instrument was placed on the outside of the dominant ankle and the dial was locked.
   c. The subject then raised the foot in an arc to as near the buttock as possible, keeping the opposite knee straight and both knees together, and the pointer was locked.
   d. The subject was allowed to brace with the hands.

4. Neck flexion and extension
   a. The subject assumed the supine position on a bench, with the head and neck projecting over the end, and the shoulders touching the edge, with the arms at the side.
   b. The instrument was fastened to the side of the head over the ear.
   c. The subject raised the head to a position as near the chest as possible, and the dial was locked.
   d. The subject lowered the head to a position as near the end of the bench as possible, and the pointer was locked.
   e. The shoulders were not allowed to be raised from the bench during flexion, nor was the back allowed to be unduly arched during extension. The buttocks and shoulders remained in contact with the bench during the movement.

5. Arm flexion on the back
   a. The subject stood at attention with the thumb and forefinger placed on the lateral crest of the ilium, the wrist straight, and the feet apart enough to give solid stance.
   b. The instrument was fastened to the underside of the wrist, and the dial locked.
   c. The subject placed the hand as far up the back as possible in a hammer lock position, and the pointer was locked.
   d. During the movement, the body was not allowed to bend forward or sideways, nor was the position of the feet allowed to change.

The score for each of the tests was the number of degrees through which movement took place.

Clarke's Strength Composite

The following equipment was utilized for all of the strength composite measures:
Cable-tensiometer
Cable-tension testing table
Regulation strap
Body strap
Shoulder brace
Goniometer

1. Shoulder extension strength
   The subject assumed the supine position, with the hips and knees flexed comfortably and the left hand on the chest. The upper right arm was flexed to 90 degrees, with the elbow flexed and the forearm across the chest. The regulation strap was placed around the upper right arm midway between the elbow and shoulder joints. The pulling assembly was attached to the wall behind the subject's head. The subject's shoulders were braced from behind, shoulder elevation was prevented, and the elbow was kept in line with the pull.

2. Hip extension strength
   The subject assumed the prone position on the table with the arms along the sides and the right leg extended over the table slit. The regulation strap was placed around the right thigh, on the lower third between the hip and knee joints. The pulling assembly was hooked beneath the leg through the slit. The hips were braced to prevent lifting, and the portion of the leg below the strap was not allowed to touch the table.

3. Trunk flexion strength
   The subject assumed the supine position with the upper back over the slit; the legs were straight and together and the arms were folded on the chest. The trunk strap was placed around the chest close under the armpits. The pulling assembly was hooked beneath the subject through the slit. The legs were braced across the thighs.

   Scoring
   The score for each individual test item was the reading in cable-tensiometer units indicated by the maximum pointer on the tensiometer dial. The composite score was obtained by summing the three individual scores.